NUTRITION REVIEWS

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FEEDING THE AMERICAN SOLDIER

Morale determines the fighting value of the soldier; and to an enormous degree the food he eats determines the quality of his morale. This promises well for American arms, for ours are the best fed fighting men in the world. It is not simple to maintain this standard. As new arms and new strategy are introduced, new methods of rationing must be devised. The rapidity with which troops move today, the extremes of temperature under which they work and fight, the high altitudes at which they must exhibit alertness and initiative, and the ever increasing use of processed foods all present new and intricate nutritive problems.

In the solution of these problems several agencies are engaged. The Quartermaster Corps which is charged with the duties of procurement and supply as well as that of developing rations conducts a Subsistence Research Laboratory under the direction of Colonel Rohland A. Isker. The Medical Department which is responsible for the general supervision of the soldier's nutrition has a Nutrition Branch under the direction of Colonel Paul E. Howe. The National Research Council which advises the government on questions of a scientific nature has a Subcommittee on Medical Nutrition. Close liaison is maintained between all of these agencies.

The Garrison Ration and the Field Ration present few difficulties. The latter has replaced the former except in general hospitals and certain small stations, and is now used in all army camps, posts, and stations within the United States. Field Ration A is issued on the basis of master menus made up by nutritional specialists in the office of the Quartermaster General and is subject to review by the Commanding General of each service company and by the commandant of each Post so that necessary changes may be made to fit the local situation. The ration is governed by market availability, and care is exercised to see that "the menu is nutritionally balanced, ample variety provided, and full utilization made of seasonal fresh fruits and vegetables." That this order is being observed with fidelity can be seen in the following table prepared from data provided by Colonel Howe. A major difficulty in determining the nutritive value of the foods eaten is in estimating the losses that occur in storage and cooking, but these problems are now in a fair way of being solved. Taking the Recommended Daily Allowances of the Food and Nutrition Board of the National Research Council as a guide, this ration can be regarded as liberal, particularly as to its protein content. One reason for this last is to insure a good intake of the vitamin B-complex.

When the soldier is fighting, then his feeding becomes a more difficult matter. Not only must his food be adequate, but in this day of motorized warfare it must be easily transported and immediately available. These specifications are met in the Type C ration which consists of previously cooked or prepared food, packed in six hermetically sealed cans. Three of these cans contain a meat and vegetable stew or hash and three contain biscuits, sugar, and soluble coffee. This food may be eaten hot or cold. Another example is the "5-in-1 Ration," which consists of canned evaporated and dehydrated foods in quantities sufficient to supply five men for one day. For limited periods it is sufficient for seven men. Three different combinations of food are provided; these are packed in a case with the nonrigid containers assembled into a single wax-dipped carton within the case. These ra-

tions are thoroughly acceptable and are nutritionally adequate.

More difficult to arrange have been the rations designed to be carried on the soldier's person, sometimes called task rations. For this purpose a single food is occasionally suggested, but this has not proved feasible. Although a single food ration is in theory nutritionally possible, experience indicates that a combination of several foods is much more acceptable. The food must be palatable as well as nutritionally adequate; it must have minimum thirst provoking qualities; and it must be compact and stable. Such a ration is provided in the Type K pocket ration packed in three durable cartons which together weigh about two pounds. The three units contain two different types of biscuits, canned meat or cheese, a confection, a beverage concentrate, chewing gum, and four cigarettes. The meat units, confections, and beverages are different for each of the three meals. This provides about 3000 calories. Rations of this type are not fixed, but are changed from time to time as experience indicates. The Subsistence Research Laboratory has shown great resourcefulness and skill in their development.

Food Prescribed and Consumed in the U. S. Army, and Nutritive Values, as Determined by 117 Nutrition Surveys (Howe)

	Average Weight (Pounds per Man per Day)	
	Issued	Consumed
Meats	.940	.935
Eggs	.150	.145
Milk and milk products	1.030	.974
Butter	.088	.091
Other fats	.073	.075
Grains and products	.651	.578
(Bread)	(.307)	(.312)
Legumes	.052	.057
Sugar and sirups	.261	.263
Leafy green or yellow vegetables	.387	.314
Tomatoes	.137	.133
Citrus fruits	.205	.229
Potatoes	.769	.650
Other vegetables	.278	.212
Fruits	.348	.365
Fruits, dried	.063	.017

	Average Nutritive Value of Food	
	Issued	Consumed
Calories	4,101	3,888
Protein.....grams	130	124
Fat.....grams	193	193
Carbohydrate.....grams	460	415
Calcium.....milligrams	954	883
Phosphorus.....milligrams	1,946	1,882
Iron.....milligrams	25	28
Vitamin A.....I.U.	10,760	9,255
Thiamine.....milligrams	2.2[a]	2.1[a]
Riboflavin.....milligrams	3.0	2.8
Nicotinic acid....milligrams	32.0	27.4
Ascorbic acid.....milligrams	93.2[a]	86.0[a]

[a] Corrected for moderate cooking losses.

The extremes of environment, notably of temperature, humidity, atmospheric pressure, and noise, in which the American soldier may be called upon to live have presented many unexpected nutritional problems. Likewise, the changes which his food may undergo while stored in such an environment and while being processed preparatory to storage and transportation must be determined with reasonable accuracy. Questions of this nature are presented to the National Research Council by the Army, Navy, or Coast Guard. Some can be answered immediately; others require

extended research. These latter often form the basis of proposals for contract submitted by investigators through the Subcommittee on Medical Nutrition and its parent committee on Medicine to the Committee on Medical Research. If in the opinion of these bodies a proposal has sufficient merit it is sent to the Office of Scientific Research and Development for further review, and on its acceptance funds are made available to support needed research. In this way many problems which concern the feeding of the soldier are solved.

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VITAMINS AND FATIGUE

Too few reliable studies have been made on the relation of vitamin intake to physical fatigue due to hard muscular work. The war, with the essential need of maintaining the soldier in the best physical condition and providing him with the maximum endurance for continuous physical work, has stimulated this type of research. The purely impressional character of much of the previous work has been replaced by recent controlled and objective studies. It appears from these studies that individuals suffering from deficiencies of the vitamin B-complex tire easily and show greatly diminished ability to do work. This is true even if the deficiency is mild and not accompanied by frank clinical manifestations. The administration of B-complex vitamins to such individuals causes them to lose their lassitude promptly and makes them much more efficient workers. The feeding of B-vitamins in excess of the recommended allowances does not, however, increase the physical ability of normal individuals.

Foltz, Barborka, and Ivy (*Proc. Central Soc. Clin. Res.* **15,** *20 (1942)*) studied the work output of 4 medical students who pedaled a bicycle ergometer to complete exhaustion three times a week. After a training period of nine to twelve months on a normal adequate diet, the subjects were fed a diet deficient in the vitamin B-complex which provided approximately 0.33 mg. of thiamine and 0.49 mg. of riboflavin per day. At the end of two months, the fat content of each diet was reduced by 50 per cent and replaced by an isocaloric amount of carbohydrate. This regime was continued for three weeks. All subjects complained of lack of pep, anorexia, and leg pain during work periods and their work output was decreased in all instances. During this period, none of the subjects showed any clinically recognizable signs of deficiency disease. The levels of thiamine and pyruvic acid in blood remained normal throughout; however the twenty-four hour urinary excretion of thiamine during this time varied from 5 to 35 micrograms. While the deficient diet was continued, the subjects were given a daily supplement of 25 g. of yeast concentrate which provided 15 mg. of thiamine, 5.25 mg. of riboflavin, 50 mg. of niacin, 5 mg. of pyridoxine, and 25 mg. of pantothenic acid. A prompt increase in the work output occurred in all instances.

A somewhat similar investigation has been reported by Johnson and co-workers, (*J. Nutrition* **24,** *585 (1942)*) of the Harvard Fatigue Laboratory. One of their objectives was to determine how rapidly physical deterioration might begin on a diet deficient in the vitamin B-complex. The effect of thiamine in preventing such deterioration and the use of the B-complex administered as dried brewers' yeast were also studied.

Experimentally, 10 young men in different states of physical training were subjected to heavy daily physical work. This consisted in chopping, sawing, and splitting of

logs, stone lifting and carrying, and 7 to 20 mile hikes. Each morning and evening the subjects performed a physical fitness test which had been devised earlier at the Fatigue Laboratory. It consisted in pulling a stone-boat loaded so that the pull was one-third the subject's own body weight, over a flat 300 yard course at a definite rate, a procedure which commonly led to a failure of completing the course because of physical exhaustion. By means of a formula involving the duration of the standard exercise and the pulse rates during recovery, a numerical index was assigned to the degree of physical fitness. Other tests done less frequently at the laboratory consisted in moderate and exhaustive treadmill work with measurement of pulse, ventilation, oxygen consumption, carbon dioxide output, and electrocardiograms. Urinary thiamine excretions were also measured.

Preliminary measurements were made for one week while the subjects were on a normal diet. During the following week of manual exercise, all the subjects were placed on a basal deficient diet. Five were given 2 mg. of thiamine hydrochloride daily and the others a placebo. The basal diet allowed a certain choice of foods and was considered adequate in protein, vitamins A and D, ascorbic acid, and riboflavin, but inadequate according to present standards in thiamine, niacin, pyridoxine, and pantothenic acid. The diet was known from previous work to maintain weight for at least six weeks, and during the manual work period supplied 4000 to 5000 calories.

Within six days on the deficient diet, the subjects not receiving thiamine all developed to various degrees the symptoms of lassitude, inefficiency, depression, easy fatigue, and poor appetite. They also developed muscle and joint pains which were much different from the stiffness following unaccustomed exercise, and which became steadily worse. They showed a marked decrease in the physical fitness test and an abnormally high pulmonary ventilation during the moderate treadmill work. The subjects who received thiamine also showed a decrease in the physical fitness test, commonly complained of "easy fatigue," but had few other symptoms and only slight alteration in pulmonary ventilation.

All the subjects were then given 18 g. of dried brewers' yeast daily and continued the basal diet. The yeast supplement provided approximately 0.5 mg. of thiamine, 1.2 mg. of riboflavin, 11 mg. of nicotinic acid, 1.5 mg. of pyridoxine, and 3.6 mg. of pantothenic acid. After a two day period of yeast therapy, a characteristic and "sudden" improvement occurred in all the subjects. The subjects all showed a rapid improvement in the physical fitness test. Within six days nearly all were back to normal in this respect; in fact most of the subjects became more fit than at the beginning of the test as a result of the training. The group which had previously received the thiamine supplement responded somewhat more rapidly than the others, even though they were receiving only 0.5 mg. of thiamine supplement during the yeast-feeding period.

The authors therefore conclude that hard physical work necessitates an adequate amount of the vitamin B-complex. From previous experience and comparison with the results of others, they are also convinced that such physical work leads to symptoms and signs of deterioration much faster than sedentary subjects on a similar diet. It appears therefore, that men doing hard physical labor even for a few days have an imperative need for an adequate daily intake of the vitamin B-complex if physical fitness is to be maintained. Thiamine is not the only member of the vitamin B-complex which is important in this respect since, although the subjects receiving thiamine alone were spared some of the symptoms, they nevertheless showed the physical deterioration.

It is perhaps unfortunate that the subjects did not undergo a more extensive training

period before institution of the diets. It would have been desirable to enforce the various periods of the two groups at different times during the experiment, particularly to observe whether an improvement could be reversed. Such a procedure would have served to eliminate the possible effects of training. The rapid improvement in the physical fitness test with yeast therapy might have been partly influenced by the effect of training, and even the knowledge on the part of the subjects that the physical strain of the experiment was nearing completion, might have had its effect on complaints and physical ambition. However, the differences between the two groups appear to justify the authors' conclusions.

Keys and Henschel (*J. Nutrition* **23,** *259 (1942)*) attempted to determine whether a superabundance of vitamins over standard Army Post rations would produce any increased stamina or resistance to physical strain. Each of 26 soldiers underwent a preliminary training period of two to four weeks to eliminate the factor of training from subsequent evaluation of physical endurance. To eliminate this factor further, some of the subjects received their vitamin supplements early in the experimental period, others at a later time. The daily vitamin supplement included for some as much as 17 mg. of thiamine, 100 mg. of nicotinamide, 20 mg. of calcium pantothenate, 10 mg. of riboflavin, 10 mg. of pyridoxine, and 200 mg. of ascorbic acid. Placebos were issued during control periods. The exercise consisted of marching with a standard pack for a definite period of time on a treadmill at constant speed and angle of climb. This exercise was severe, considered "beyond the capacity of the average untrained college student." Physiological and biochemical measurements were made during a preliminary period of rest and at successive stages of recovery after the exercise. These measurements consisted of the pulse rate, heart size, stroke output of the heart, oxygen consumption, respiratory quotient, urinary nitrogen and ketone body excretion, and concentration in the blood of lactate, sugar, hemoglobin, ketone bodies, and in some cases sugar tolerance curves.

Subjectively, only one man noted a marked change in ability to perform the exercise but this was the same in both the placebo and vitamin supplementation periods. Other instances of apparent improvement occurred in either period. Objectively there were also no changes which could be related directly to vitamin supplementation. The marked lactic acid increase and blood sugar decrease were not different in either the placebo or vitamin supplementation periods. Sugar tolerance curves at the end of an exercise period resembled those of a mild diabetic with accompanying mild ketosis, but this was also unrelated to any particular period of vitamin intake.

The observations were not limited to a short experimental exercise period but also included observations over a twenty-four hour period of semistarvation, again without showing any beneficial signs during the vitamin supplementation period.

It must be pointed out that the Army Post rations were of high standards, supplying at least 1.7 mg. of thiamine chloride, 2.4 mg. of riboflavin, and 70 mg. of ascorbic acid daily. The experiments were designed to show whether vitamins in excess of accepted requirements improve physical vigor and capacity to work, either subjectively or by the criteria of several objective tests.

These reports are not in conflict. They emphasize the necessity for maintaining optimal vitamin intakes of working and fighting men, but explode the too prevalent idea that because an adequate diet is necessary for physical stamina, extra vitamins will produce an overabundance of energy and physical ability.

AVAILABLE IRON IN FOODS

The production of anemia in young rats fed exclusively a cow's milk diet made it possible to study the various factors operative in the cure and prevention of nutritional anemia (Waddell, Steenbock, Elvehjem, and Hart, *J. Biol. Chem.* **77,** *769 (1928)*). It was impossible to raise the hemoglobin level of such animals by administration of pure iron salts, although dried or ashed beef liver or lettuce gave a positive response (*J. Biol. Chem.* **77,** *777 (1928)*). Chemical examination of the ashed residues of anemia-curing foods led the Wisconsin workers to the conclusion that traces of copper were necessary in addition to iron for hemoglobin regeneration. After general agreement had been reached that copper functions only in the utilization of the iron for hemoglobin formation, it became a major problem to determine the relative "availability" of iron in different foods.

The finding of Elvehjem, Hart, and Sherman (*J. Biol. Chem.* **103,** *61 (1933)*) that "hematin iron" was not available for hemoglobin formation led to the general finding that the total iron content of various foods was not equally utilizable for hemoglobin synthesis. The term "per cent available" or simply "available" iron referred to that portion that could be utilized for hemoglobin formation in the anemic rats. A comparison of available iron with that which could react with the reagent $\alpha\alpha'$ dipyridyl showed fair agreement so that the term "ionizable" iron was also used to connote the biologically active iron content of foods. The dipyridyl method yielded the following figures for per cent availability of the iron in various foods: egg yolk 100, pork heart 86, soybeans 80, beef liver 70, oats 57, apricots 50, wheat 47, parsley 22, and spinach 20. Of interest was the relatively high availability of the iron in animal products as compared to the low proportion available in certain vegetables.

More extensive studies have been reported by Shackleton and McCance (*Biochem. J.* **30,** *582 (1936)*) on the available iron content of 155 British foodstuffs. Smith and Otis (*J. Nutrition* **13,** *573 (1937); Ibid.* **14,** *365 (1937)*) in a study of the rat biologic assay method have stressed the variance of response with respect to sex and emphasize the necessity of adequate copper during the depletion of iron reserves in order to prevent the copper content of the food becoming a complicating factor.

Ascham, Speirs, and Maddox (*J. Nutrition* **16,** *425 (1938)*) made a study of the hematopoietic value of leafy vegetables both by the bioassay and dipyridyl methods. They noted considerable interference by plant pigments on the chemical method and adsorption of the dipyridyl color complex on the plant tissue. Certain technical changes in the chemical method resulted in values of 60 to 70 per cent ionizable iron in several raw or cooked leafy vegetables, values which agreed fairly well with those of Shackleton and McCance but which were considerably higher than earlier values with the dipyridyl method. Discrepancies were still noted between the chemical and biologic assay methods.

The most recent study along these lines has been reported by Theriault and Fellers (*Food Research* **7,** *503 (1942)*). Their particular object was to study the effect of freezing and of canning in glass or tin on the available iron content of sweet corn, asparagus, green snap beans, lima beans, spinach, red sea perch, and peaches. Frozen foods and part of the fresh foods were dried as received and the remainder of the fresh foods canned in glass jars, C-enamel (zinc enamel), fruit enamel, or plain tin cans. Glass jars were opened and the contents dried after one month of storage; tin cans were opened and the contents dried at intervals of thirty, one hundred, and two hundred days after canning. The food was dried to increase the accuracy of sampling and to provide uniform material for bioassay. Drying was carried out at 120°F. on wax paper or in aluminum dishes, followed by grinding in a "newly

galvanized food chopper," and pulverizing in a ball mill.

On the basis of a relatively small number of bioassays, the authors report good agreement between the dipyridyl estimate of available iron and the biologic test, with the exception of spinach where a discrepancy was attributed to the laxative effect of the spinach. The per cent availability of the iron of several frozen foods was reported as follows: sweet corn 100, asparagus 60, green snap beans 61, lima beans 73, spinach 63, and red sea perch 19. These same foods after two hundred days in tin or C-enamel cases were found to have 96, 49, 48, 65, 54, and 8 per cent available iron, respectively.

These general conclusions were reached: (1) the total iron in frozen foods was lower than in fresh foods, believed due to a loss of soil particles during blanching and washing prior to freezing; (2) iron availability was higher in frozen foods than in similar fresh or canned foods, considered a result of tissue disintegration due to freezing and thawing; and (3) canning in glass had no detrimental effect on iron availability.

It was also noted that a high acidity of the canned contents (pH 3.9 in the case of peaches) caused increases in the total and available iron while at higher pH values (pH 5.4 for asparagus, pH 6.9 for red sea perch) there was a loss of iron. In the case of red sea perch, 52 per cent of the total iron and nearly all of the available iron was lost during 200 days of storage. These effects are based on the "reversal of E.M.F. in the iron-tin couple at the pH and ionic concentrations obtained in the cans." In cases where iron is gained during canning, the authors believe that the iron gained is nearly 100 per cent available.

These results are not simple to evaluate. The treatment of the foods used for chemical analyses for total and available iron, as well as for the bioassays, may have introduced changes that cannot be attributed to freezing, canning, or even to storage. For example, some foods were dried in aluminum dishes and all foods were ground in a food chopper. It would be extremely difficult to galvanize the grinding surfaces or knives of a food chopper. Thus iron contamination is a possibility. Furthermore, all foods were pulverized in a ball mill, introducing further opportunity for introduction of impurities. Possibility exists for aluminum, zinc, and iron contamination after the experiments on freezing, canning, and storage were completed. It is difficult to accept the interpretation of the data on red sea perch and asparagus. After storage for 30, 100, and 200 days (in zinc enameled cans) red sea perch had 36, 25, and 24 p.p.m. total iron and 4, 2, and 2 p.p.m. available iron, respectively. Asparagus, on the other hand, stored for 30, 100, and 200 days (in plain tin cans) yielded 108, 106, and 96 p.p.m. of total iron and 55, 52, and 42 p.p.m. of available iron, respectively. In other words, it would appear that the plain tin can took up as much total iron and more available iron than the zinc enamel can was able to remove from the red sea perch. Industrial canning scientists have long held that asparagus removes iron from the can rather than the reverse as reported by Theriault and Fellers. Unless all factors affecting the accuracy of data collection can be carefully controlled, it is dangerous to generalize. The data presented offer insufficient basis for drawing conclusions as to the effect of any of the food preservation methods used on the availability of iron.

NUTRITIONAL STATUS OF A POPULATION GROUP IN MADRID

Spain has not fully recovered from the food shortages which developed during her Civil War. There have been times when the lack of food has been acute and large groups of the population have had to be fed from soup kitchens. Several years ago iso-

lated reports appeared in Spanish and German medical journals describing the increase of pellagra, particularly in Madrid. There has been little precise information, however, on the degree to which the health of the Spanish people has been impaired by their inadequate food allowances. A recent report, therefore, which evaluates the nutritional status of a population group in Puente de Vallecas, an industrial suburb of Madrid, during the summer of 1941, is of great interest to all students of nutrition. Robinson, Janney, and Grande (*J. Nutrition* **24,** *557 (1942)*) made a study on 106 families composed of 561 persons. Approximately one third of the subjects received a substantial amount of their food from the official relief agency. Nearly 50 per cent of the total number were children under 13 years of age and there were fewer men than women between the ages of 20 and 40 years. The total sample represented less than 1 per cent of the population of the district and was weighted with a larger proportion of families receiving relief assistance.

Dietary records on each family were collected by determining the consumption of foodstuffs for seven consecutive days. These were supplemented by accounts of the food eaten by individual members of the family, expressed in terms of household measurements, for three days. Dietary constituents were calculated from the few food tables available for Spanish foods, but for the vitamins and minerals, analyses from other countries had to be used. In order to standardize records, average individual consumption was expressed in terms of "adult male consumption units" (determined by using the caloric coefficients of Begwood League of Nations Technical Commission on Nutrition, Geneva, 1939). The following mean values were obtained in terms of adult male consumption units per day: 1602 ± 61 calories, 238 ± 10 g. of carbohydrate, 42 ± 3 g. of fat, 66 ± 2.7 g. of total protein, 22 ± 1.7 g. of animal protein, 0.301 ± 0.018 g. of calcium, 1.02 ± 0.036 g. of phosphorus, 11.4 ± 0.43 mg. of iron, 3852 ± 273 I. U. of vitamin A, 0.82 ± 0.03 mg. of thiamine, 0.542 ± 0.29 mg. of riboflavin, and 47.4 ± 2.8 mg. of ascorbic acid. The niacin content was not calculated because reliable values were available for only a few of the foods. Variations among the family groups were rather large. The chief articles of food were a coarse, dark brown, whole grain bread; olive oil; potatoes; fresh vegetables (string beans, lettuce, tomatoes, chard); fish; and sometimes rice and milk. Meat, eggs, cheese, and fruits were practically unknown or beyond the financial reach of these subjects. Analysis of the diet shows that a high proportion of the total energy was derived from carbohydrate, little of the protein was animal in origin, the calcium intake was small, and the levels of vitamin A and riboflavin were low. Adequate amounts of iron, thiamine, ascorbic acid, and phosphorus were probably provided. The authors estimate that the mean caloric intake should have been approximately 2800 calories. The low caloric intake available, therefore, probably exerted a protective effect on the vitamin and mineral requirements.

The incidence of classic deficiency was slight: there were 2 cases of definite nutritional edema, one subject with glossitis and a chronic pellagrous dermatitis, and two children with roentgenologic evidence of classic rickets. No cases of xerophthalmia, scurvy, beriberi, or specific cheilosis were observed. Many of the subjects had shown weight loss. Over a third of the children were noted to have flaring rib margins and flaccid abdominal musculature. Three fourths of the subjects over 5 years of age complained of weakness and ease of fatigue. Irritability, apathy, and loss of memory were frequent complaints. Thirteen persons complained of night blindness and 72 presented skin lesions with horny spines in the hair follicles. A large number of the subjects complained of paresthesias in the extremities with aching and tenderness in the muscles. Robinson and associates hesitate

to attribute these latter manifestations to a thiamine lack because they believe the thiamine intake was adequate and because a similar syndrome, observed during the siege of Madrid, was shown to respond to yeast but not to thiamine alone. Gastrointestinal symptoms and the few skin lesions observed were difficult to evaluate. Sixteen per cent of the males and 26 per cent of the females had eye changes which might be attributable to ariboflavinosis. Thirty-five subjects gave a history of edema but only 4 cases of minimal and 2 cases of frank edema were observed. The children's development status indicated a retardation of one to three years as compared with standards for American children. Comparison with American standards indicated that 332 individuals were more than 7.5 per cent underweight and 213 more than 12.5 per cent underweight.

It is of public health interest that 48 of the 521 subjects had serious organic disease, and of these 13 had tuberculosis. An additional 17 subjects were suspected of having that disease.

The laboratory studies on these persons indicated that 16 per cent of the males and 18 per cent of the females had hemoglobin values below 12 g. per 100 ml. Red cell counts were below 4,125,000 in approximately one third of the group. Furthermore, 32 per cent of the men and 27 per cent of the women had macrocytic red cells. Macrocytic hyperchromic anemia was the chief hematologic abnormality observed. Serum albumin values were below 4 g. per 100 ml. in 11 per cent of the males and in 5 per cent of the females. About one third of the subjects had serum vitamin A levels below 55 I. U. (normal values about 100 I. U.). The values tended to be lower in children. The ascorbic acid content of serum was reported as indicating that nearly all subjects were receiving an adequate amount of this vitamin.

Robinson and associates caution against regarding these observations as characteristic of all of Spain. The study was both localized and seasonal. There is evidence that the nutritional status varies in different sections of the country. As stated earlier, there is even some reason to suspect that sampling within the community studied was not perfectly balanced. In order to secure cooperation of the subjects, 1 kg. of white flour or 2 cans of evaporated milk were offered to each individual who completed the study. The report is welcomed, however, as a careful, painstaking documentation of this one population group. There are unquestionably countless other communities in Europe whose present nutritional status is comparable to or worse than that of Madrid. It is staggering to consider the permanent physical, and possible mental, handicaps which are probably being imprinted on large population groups because they have become malnourished.

NIACIN FOR ANGINA PECTORIS

Molitor (*Fed. Proc.* **1,** *309 (1942)*) has pointed out that vitamins are relatively lacking in conspicuous pharmacodynamic properties, except when their actions are studied on vitamin deficient tissues and organisms. Clinicians however have been interested in the possibility that these physiologically potent substances may be useful in the treatment of conditions that may not be related in any way to nutritional deficiency. The results to date have not been startling but much interest has been aroused by the report of Neuwahl (*Lancet* **II,** *419 (1942)*) that he has found niacin to be of benefit in the treatment of patients with angina pectoris. Although the amide of nicotinic acid, in which form the vitamin appears to occur in foods, has

no untoward effects, it has been observed repeatedly that the administration of the free acid, niacin, may be accompanied by flushing of the face, hot flashes, and sweating. These vasodilatory reactions are transitory and are seldom produced except with dosages of 50 mg. or more of niacin. The effect is confined largely to the peripheral circulation, there being no increase in blood pressure but frequently a decrease, accompanied by a moderate slowing of the heart rate. It has been shown that the effect is also produced in the blood vessels of the brain. For these reasons niacin has been studied clinically in the treatment of trigeminal neuralgia, of certain types of cerebral circulatory disturbances, and of similar conditions in man, as well as in the recently reported study of its action in patients with angina pectoris. All these studies are still in the experimental stage and they are of interest primarily because they may point the way to further research on effective drugs for the management of some of the circulatory disorders.

Neuwahl has stated that for present purposes he abandoned the oral administration of niacin because of inconstant and temporary results. Later he tried intravenous administration with uniformly beneficial and lasting effects. From 100 to 300 mg. of niacin in the form of a 0.05 per cent solution is administered by drip infusion. It is reported that six infusions administered during the course of about three weeks are sufficient. When so treated 6 patients showed complete regression of symptoms for periods of from three to seven months, and 3 of these persons were able to resume their normal activities which involved at times some heavy work. Moderate exertion could be undertaken without precipitating the excruciating and debilitating pains to which the sufferer from angina pectoris is liable. Not only is the method of treatment in the experimental stage, but it is evident that it is best performed by clinicians who have adequate hospital facilities.

Within two minutes after beginning the infusions the patients may develop a flushing of the skin of the face and upper extremities. There usually is a reduction in systolic blood pressure and in heart rate. Neuwahl has also studied the pharmacologic properties of niacin and he has pointed out the striking similarity in most instances between the effects produced by this substance and those produced by small amounts of histamine, which incidentally bears no chemical relationship to niacin. Thus, for example, injections of 0.1 mg. of histamine or of from 5 to 50 mg. of niacin produce a rise in volume and acidity of the gastric secretion. Somewhat similar effects are produced by either substance on smooth muscle, but there is a difference in their effect on blood pressure and on the heart rate. These comparisons however pertain to the immediate effect of both substances. The interesting point about the observations of Neuwahl in connection with the treatment of angina pectoris is the lasting effect that has been observed. In one of his cases a patient showed considerable improvement within twenty-four hours after a single injection. These studies emphasize once more the unforeseen possibilities of investigations of substances which we recognize primarily as nutrients.

PHYSIOLOGY OF PANTOTHENIC ACID ANALOGUES

One of the greatest medical advances of the past decade was the discovery of the sulfonamides and the application of these to the treatment of bacterial infections. Recent work makes it probable that the mechanism of the bacteriostatic action of the sulfonamides is concerned with the similarity of their chemical structure to

p-aminobenzoic acid, an essential factor in bacterial growth. There is thus a competition between the drug and the growth factor for a position on an enzyme surface, the normal combination being required for proper metabolism and growth of the bacteria. Such competitive inhibition of enzyme reactions has long been recognized by enzyme chemists. This general knowledge suggests that if the chemical structure of bacterial growth factors is known, efficient bacteriostatic agents might be synthesized on a rational basis. Since such "competitive" drugs must also have an effect on the metabolic processes of the host, the ideal drug would be one chemically related to an essential bacterial growth factor, a substance perhaps not essential in human nutrition.

Pantothenic acid is required for the growth of mammals and microorganisms, and probably for all forms of life. Barnett and Robinson (*Biochem. J.* **36,** *357 (1942)*) have prepared several analogues of pantothenic acid and tested their bacteriostatic action.

Chemically, pantothenic acid is known as α,γ-dihydroxy-β-β-dimethyl-butyryl-β'-alanine, and for purposes of discussion may be considered to be derived from two units, a lactone and a β-amino acid. Replacement of the lactone and amino acid normally found in pantothenic acid by chemically similar molecules resulted in pantothenic acid analogues which in general lacked the growth-stimulating property of the natural vitamin. In a further study (*Biochem. J.* **36,** *364 (1942)*) the same authors developed similar compounds which lacked pantothenic acid activity but which would act antagonistically. These analogues contained the lactone (pantoyl) condensed with taurine instead of β-alanine. These substances were highly inhibitory to *streptococcus hemolyticus* and to some strains of *corynebacterium diphtheriae*. The inhibition by pantoyltaurine was dependent on the amount of pantothenic acid present, being less in the presence of excess pantothenic acid. This therefore apparently represents the competitive type of inhibition found with the sulfonamides and p-aminobenzoic acid.

Snell (*J. Biol. Chem.* **139,** *975 (1941)*) prepared pantoyltaurine and found that it also inhibited the growth of *Lactobacillus arabinosus, streptococcus lactis* and *propionibacterium pentosaceum*. From the chemical standpoint it appeared that those analogues which lacked an "α-hydroxy" group in the lactone structure were irreversible inhibitors, in contrast to those whose inhibition was reversed by pantothenic acid.

These studies not only suggest specific compounds for clinical testing, but offer a new approach to chemotherapeutic experimentation.

DIETARY PROTEIN AND THE ABSORPTION OF CALCIUM

Lehmann and Pollak (*J. Physiol.* **100,** *17P (1942)*) suggested that amino acids might facilitate the intestinal absorption of calcium since they had found that phosphates and carbonates of calcium and magnesium were much more soluble in solutions of amino acids than in pure water.

McCance, Widdowson, and Lehmann (*Biochem. J.* **36,** *686 (1942)*) explored this suggestion by performing balance studies in man. Five subjects, four men and one woman, were studied on both high and low protein intakes. The low protein diet contained 45 to 70 g. of protein and fixed proportions of milk, wheat meal bread, potatoes and other vegetables, sugar, and fats. The high protein diet contained an additional 100 to 130 g. of protein, balanced in control experiments by an equicaloric ration of sugar or fat. The additional protein

was in the form of peptone, gelatin, gluten, or egg white; the calcium, magnesium, and phosphorus content being equalized in control diets by salt mixtures. The diets were also low in calcium, supplying an average of 630 mg. per day.

The authors calculated the amount of calcium absorbed by subtracting the feces calcium from the intake. With an equivalent calcium intake, the high protein diet resulted in absorption of 94 mg. as compared to 32 mg. on the low protein diet, representing respectively 15 and 5 per cent absorption of the calcium intake. The greater calcium absorption was also reflected in a greater excretion in the urine, 107 mg. daily as compared to 72 mg. on the low protein diet.

The high protein diet led to a 41 per cent absorption of the dietary magnesium in contrast to 32 per cent on the low protein diet. The authors suggest that no adequate evidence has yet been offered to indicate a similar effect of protein on the absorption of phosphorus or iron.

It has been known for some time that lean meat has a definite antirachitic effect and that skim milk decreases the vitamin D requirement. In spite of a low calcium but high protein diet, the Eskimo possesses excellent teeth and bones. These facts might have their basis in the favorable effect of the amino acids on the absorption of calcium. The use of meats and other foods high in protein might therefore have a special importance in pregnancy and lactation. The use of such a diet might convert an otherwise calcium-poor diet into one supplying adequate amounts of this mineral.

SOME PROBLEMS OF NUTRITION IN AVIATION

Lieutenant Howard R. Bierman of the Medical Corps, U. S. Naval Reserve, has reviewed some of the problems of nutrition that are peculiar to aviation medicine (*War Medicine* **3,** *1 (1943)*). At the present time competent investigators in both the Army and the Navy are studying some of these problems. Other investigators in university laboratories are studying various aspects of the subject under the watchful eye of the Office of Scientific Research and Development. Much of the information that has been obtained must be considered confidential. For this reason Lieutenant Bierman's report can hardly be complete but the material which is discussed will be of interest to many students of nutrition. In bringing to the attention of readers some of the problems that confront our air forces the author expressed a desire to stimulate independent investigators to devote additional effort to the study of nutrition in aviation medicine.

The problems which the author discussed include those concerned with the condition commonly called airsickness, those which result from the subjection of the body to marked accelerative forces, the special problems presented by obese persons, and, finally, the difficulties presented by the expansion of gases in the intestinal tract at high altitudes.

The condition of airsickness is considered as a functional neurosis characterized by nausea, vomiting, apprehension, faintness, sweating and sometimes prostration. It occurs as a rule from acceleration during flight. As in seasickness, the sight or odor of food may precipitate airsickness or aggravate the condition. Persons are particularly prone to develop airsickness on an empty stomach or following a heavy meal rich in fat. It is believed that a light bland meal about one or two hours before flight is best tolerated. Bierman suggests that the meal served to an airsick person should be either piping hot or ice cold, and only small amounts of fluid should be offered. It has

been observed that persons who have eaten an hour or two before being subjected to marked accelerative force are better able to withstand such force than those who have not partaken of food. One explanation of this phenomenon may be found in the emptying of the splanchnic pool of blood by the increased circulation that is known to occur in the intestinal tract during digestion.

Obesity is undesirable for a number of more or less obvious reasons, but especially because fat affords an excellent storage for nitrogen. There is great variation in the ability of persons to withstand the "bends" that may develop at high altitudes (when air or nitrogen is less soluble in body fluids and is thought to appear as minute bubbles of gas) and there are variations in the susceptibility of the same person at different times. It appears that the obese subject is more likely to develop the bends than the less fat individual. Diet may also be important in explaining the variability in susceptibility of individuals at different times. The contributing factors are not clearly defined.

The personnel of aircraft which are flown at high altitudes frequently develop severe abdominal discomfort and cramps from the expansion of gases in the alimentary tract. The reason for this condition is clear from the knowledge that a given volume of gas at sea level expands to four times this volume at an elevation of 34,000 feet. The cramps that develop may persist for as long as 24 hours after returning to sea level. It is believed that most of the air in the alimentary tract is swallowed as such. Student aviators when subjected to rapidly lowered pressures in experimental tanks have been seen to swallow unnecessarily large amounts of air in order to equalize the pressure in the middle ear with that of the surrounding atmosphere. It is possible that this source of air in the gastrointestinal tract may particularly affect the personnel of dive bombers and other types of aircraft which frequently change altitude. Bierman lists a number of factors that may lead to an excessive amount of air in the intestinal tract. These include the swallowing of air, the ingestion of gas-containing and gas-forming foods, and some pathologic conditions of the bowel. Carbonated beverages, foods that have been whipped with air, such as milk shakes and omelets, and certain grades of ice cream are examples of gas-containing foods. Gas-forming foods include beans, lentils, cabbage, sauerkraut, cauliflower, onions, eggs, large amounts of fruits and fruit juices, and fermentable drinks such as beer and malted milk. Drugs such as sodium bicarbonate and other effervescent powders likewise may cause gases to form in the intestinal tract. Abnormal ingestion of air develops as a rule from the swallowing of saliva or of fluids. It may be enhanced by the chewing of gum, smoking, or drinking of water or other fluids from bottles, glasses, through straws, or drinking from fountains with inadequate streams. All of these factors are subject to control either by elimination or by education of the personnel. Pathologic states of the gastrointestinal tract may also be a contributing factor and if this is the case medical attention is indicated.

The author develops a good argument for the frequent feeding of small meals to the personnel of aircraft. It has been observed that aviators often become hungry during flights. On the larger aircraft there may be provision for serving food, but on small planes the limitations are severe. Many aviators carry chocolate bars or other food with them. The diet recommended is one that is high in protein, moderate in carbohydrate, and moderately low in fat, with a daily caloric value of from 40 to 50 calories for each kilogram of body weight. The diet should contain large amounts of iron and calcium, and an adequate amount of sodium chloride. In the author's opinion the amount of vitamin A should exceed 10,000 I.U. daily because of the relation of

this substance to dark adaptation. Gas-containing and gas-forming foods should be reduced to a minimum in the diet of aviators. Food should be served at four-hour intervals and the meals should be light but substantial. It has been found that frequent meals help eliminate formation of gas and minimize the tendency toward airsickness. It is thought that they may lessen the possibility of hypoglycemia, and in other ways be advantageous.

The author concludes this interesting discussion with the statement that "the need for research in the field of nutrition for the aviator is apparent," with which one can only agree.

THE AMERICAN DIET

Surveys indicate that a large part of our population consumes a diet which is inadequate with respect to several of the individual food factors according to dietary standards developed by the Food and Nutrition Board of the National Research Council (*National Research Council, Reprint and Circular Series, no. 115, (1943); Nutrition Reviews*, **1,** *164 (1943)*). Although financial ability to purchase the proper foods must be recognized as one responsible factor, several reports indicate that ignorance of nutrition facts on the part of the public is at least of equal importance.

The survey of Stiebeling and Phipard (*U. S. Dept. Agriculture, Circular no. 507, (1939)*) which covered the period from December 1934 to February 1937, illustrates the need for considering both poverty and lack of knowledge of nutrition. They found that 82 per cent of city wage earners spending $1.25 to $1.87 per capita per week received diets definitely poor in one or more nutrients. Among those spending $2.50 to $3.12, 50 per cent had poor diets, and even among those with a food expenditure of $3.75 to $4.37, 26 per cent had poor diets and only 23 per cent had diets which could be considered good. The quality of food selected was obviously not merely a matter of money expenditure, since at every expenditure level above a certain minimum only a certain percentage of families succeeded in choosing a good diet.

More recently Stiebeling (*J. Am. Med. Assn.* **121,** *831 (1943)*) has summarized the older surveys and reinterpreted some of the data in the light of the newer standards for dietary requirements. She has pointed out that data on the consumption of food may yield an overly optimistic view of the situation because such figures do not take into consideration losses in the preparation and cooking of foods, and the dietary allowances of the Food and Nutrition Board, although liberal, contain no provisions for losses of essential nutrients, but consider only the fundamental requirements of the body. A case in point is Stiebeling's estimate that the per capita thiamine value of food delivered to the kitchens of the United States in the years 1936 to 1940 was 1.7 mg. as compared to the allowance, corrected for age and sex of the total population, which is considered to be 1.6 mg. The studies of Lane, Johnson, and Williams (*J. Nutrition* **23,** *613 (1942)*) indicate that the amount of thiamine actually taken into the body is about 0.9 mg. for the same number of calories (2800), an amount which is dangerously close to the generally accepted minimum requirement of 1.0 mg. for each 3000 calories.

In a recent study, Willard (*Am. J. Pub. Health* **32,** *996 (1942)*) found that a dietary survey of 1169 schoolchildren in Worcester County, Maryland, "more than confirmed the impression of poor dietary habits and the existence of a nutritional problem." Information was collected concerning the intake of 5 principal groups of foods: milk, vegetables (except potatoes), fruit, cereal or whole grain, and meat. It was revealed

that only 41 per cent of the children received 2 or more cups of milk per day. In the opinion of the author, only 19 per cent consumed adequate vegetables, 20 per cent sufficient fruit, and 41 per cent adequate cereal or whole grain. In contrast, 97 per cent of the children were thought to receive sufficient meat. Although the study included only the meals consumed by each child on the day of the survey, instead of the three day to one week record generally accepted as necessary to ascertain an individual's dietary habits, the author points out that the results probably are significant because of the large number of children involved. According to the author, "there is no reason why there should be a nutrition problem except that many of the 14,000 white and 7000 colored inhabitants are poor and ignorant, and have large families." On the other hand this section of Maryland is favored with diversified crops and ample food resources. Again it would appear that ignorance of food values is of basic importance in explaining the poor diets.

In another dietary survey among 1103 aircraft workers in southern California, Wiehl (*Milbank Memorial Fund Quart.* **20,** *329 (1942)*) reported that 56 per cent of the diets were poor in green or yellow vegetables; 49 per cent were deficient in citrus fruits or tomatoes; 33 per cent were poor in milk; 23 per cent were poor in eggs; while only 1 per cent consumed meat as infrequently as twice a week. Only 2 per cent of the diets contained satisfactory amounts of each of these five food groups, while 87 per cent were definitely below the amounts recommended by the Food and Nutrition Board. For most of the group, an increased consumption of milk, citrus fruits, tomatoes, and certain green vegetables would correct the major deficiencies of riboflavin, calcium, and ascorbic acid, and raise the intake of most other nutrients. The younger men consumed more milk and citrus fruit, and in general had somewhat better diets than the older men.

Kelly and Sheppard (*New Engl. J. Med.* **228,** *118 (1942)*) undertook a survey of individuals in the upper income group. A detailed questionnaire covering a one week period was completed by 225 private clinic patients and 223 other individuals in the upper income bracket. There were 29 physicians in the group studied. After a further personal interview with each subject, the diets were tabulated to determine the amounts of protein, fat, carbohydrate, calories, vitamins A, B_1, B_6, and D, ascorbic acid, riboflavin, niacin, calcium, phosphorus, iron, copper, and several other minerals. The food values were calculated from standard tables and compared with standards set up by the National Research Council, taking into consideration age, sex, and activity.

More diets were deficient in thiamine and riboflavin than in other vitamins or minerals. Among the private patients, 76 to 77 per cent had a deficient intake of these two factors, 26 per cent received insufficient vitamin A, and 13 per cent consumed less than the recommended amount of ascorbic acid. Among the minerals, calcium and iron inadequacies of the diet were most common. Of the foods, milk, eggs, fruit, and whole wheat or enriched grain products were most frequently lacking.

The high proportion of inadequate diets within an upper income group as reported in this study indicates again that a lack of knowledge of the nutritional values of food is common, or that there is a lack of emphasis on the needs for an adequate diet. The fact that the physicians included in the study chose no better diets than the other subjects is of interest. Apparently many of those who should be disseminating nutritional information are not fully conscious of the facts, or perhaps lack of self-discipline also plays a part.

It will be argued by many that if there is such an incidence of deficient diets, even in this supposedly well nourished country, the standards of sufficiency are set too high. It has been commented that no study was made as to whether the individuals consum-

ing the substandard diets were in any worse health than others. Undoubtedly this is an important consideration and should be given earnest attention in dietary surveys, particularly in evaluating them directly or indirectly in terms of public health. However, these dietary standards do represent the majority opinion of a group of nutrition specialists, and further, Canadian and British authorities have expressed approval of them as being in accord with the best evidence available to them.

An encouraging note has been the observation of Stiebeling in the report already cited that the records of food consumption reveal an upward trend in the dietary intakes of calcium, vitamin A, and ascorbic acid. However, it is apparent that efforts in the field of nutrition education have not been entirely successful, and that with increasing shortages and rationing of food there is an even greater need for every effort to be made to render the current nationwide nutrition program fully effective.

SOILS, CROPS, AND BETTER NUTRITION

In 1862 Congress passed the Morrill Act establishing agricultural colleges. It was not until 1887, twenty-five years later, that the Hatch Act was passed, establishing agricultural experiment stations. These experiment stations were created with the view of aiding American agriculture through research. The Adams Act (1906), the Purnell Act (1925), and the Bankhead-Jones Act (1935) provided additional funds to aid the various state experiment stations in the enlargement of their respective research programs. Throughout this period, 1887 to 1935, federal agricultural research agencies and the land-grant colleges and experiment stations conducted literally hundreds of thousands of experiments on soils, fertilizers, agricultural crops, and farm animals.

During the early years and for most of this period, the primary goal of agricultural research workers was to make two blades of grass grow where but one grew before. "Higher yields, greater production per acre," have been the watchwords of agricultural investigators and progressive farmers for many years. It is unnecessary to point to recent years of overproduction of farm crops to prove that agricultural research was capable of achieving its "quantity" goals.

Many workers and many successful farmers have long recognized that it is possible to sacrifice quality for quantity. At first, the interest in improvement of quality centered about such practical and money making problems as keeping quality, improvement of resistance to disease, attractiveness, palatability, superior shipping qualities, and similar desirable properties and characteristics of various types of farm products. It has not been until comparatively recent years that agricultural scientists have concentrated their attention on the improvement of the nutritive quality of farm products.

Since domestic animals depend almost entirely on foods derived from plants and since more than 60 per cent of man's diet is also of plant origin, it seems logical that greater attention should be paid to the various factors affecting the nutritive value of farm crops. As a result, Congress made additional funds available in 1938 for the establishment of various types of "regional laboratories" for the study of factors affecting the quality of farm products. One of these laboratories was established at Cornell University and is known as the U. S. Plant, Soil, and Nutrition Laboratory. Dr. L. A. Maynard, Director, states that it is just as important to consider yields of specific nutrients as it is to consider tons or bushels of crops per acre (*Chem. Engin. News* **21,** *217 (1943)*). He expresses the conviction that market quality is important but that nutritive quality is of even greater importance.

He states that there is evidence that "protective foods" have become less protective through a lack of appreciation of the importance of nutrition values.

The variability of thiamine in cereals is cited, where the same type of cereal may reflect differences of 100 per cent or more. Tomatoes may vary from 10 mg. to 40 mg. per 100 g. of fruit. Similar data are described for timothy hays grown on different silt loams in New York state. Differences in calcium content as high as 100 per cent and in phosphorus as high as 50 per cent were noted. Additional examples are given showing that different varieties of Canadian wheat differ markedly in thiamine content. Similar variability has been reported for vitamin C in different varieties of apples.

Maynard maintains that the starting point of good crops is good seed. Past research has given much valuable information on this question, particularly with reference to yield and resistance to disease. Genetic studies should be made regarding the effect of inheritance on nutritive value. Consequently, there is need for a thorough study of genetic and environmental factors on the nutritive value of farm crops.

He describes the organization of the new U. S. Plant, Soil, and Nutrition Laboratory in which specialists of many types are working together on the above mentioned problems. These specialists are concerned with chemistry, soils, agronomy, plant physiology, and animal and human nutrition.

In the first studies tomatoes were selected as the experimental crop because they are a good source of vitamins A and C and they are important, cheap, and easily grown under greenhouse and field conditions. An inbred variety was grown in sand culture involving "87 different combinations of macronutrients, both anions and cations." Variations occurred in growth and fruitfulness without affecting the carotene or ascorbic acid content. However, when tomatoes which were grown in different parts of the country were tested, it was found that climatic and geographic factors caused wide variations in vitamin C. When soils from these areas were sent to Ithaca, they produced tomatoes which "were substantially identical in ascorbic acid content." These experiments are in general agreement with similar experiments conducted, in the past, on the effect of climate on the protein quality of hard and soft wheats. Temperature and rainfall are usually more important than the chemical environment of the plant root system.

Experiments now underway at Ithaca involve the use of chambers in which plants can be grown under controlled conditions with respect to light, temperature, and humidity. Preliminary data indicate that the ascorbic acid content is increased by lengthening the time of exposure to fluorescent light. Studies are underway to determine the effect of restricted mineral salt intake on the mineral content of plants. Data obtained to date indicate that climatic factors are of greater importance than soil factors, as far as the nutritive value of the tomato is concerned. Similar conclusions have been drawn from preliminary data obtained on the nutritive value of turnip tops, a typical leafy food. Traces of boron seem to be necessary for synthesis of carotene in alfalfa although there is no evidence that this element plays a significant role in animal nutrition.

Maynard states that it will not be possible to buy a food with a soil or climate pedigree or with a certified analysis attached. He ventures the hope, however, that these studies may lead to a better knowledge of all factors affecting the variability in nutritive value of food plants, that such variability may be reduced, and that levels of certain nutritious ingredients may be "stepped up."

The creation of this type of research organization is a step in the right direction. Here will be developed a combination of experimental facilities that are available nowhere else. It should now be possible to

correlate genetic, chemical, physical, and climatic factors with the physiologic production of plant compounds of value in human and animal nutrition, in a manner that has not been possible heretofore. Scientific workers will watch with interest this new experiment in the expenditure of public funds in a more carefully controlled study of the various factors affecting the nutritive value of farm crops.

THE BIOLOGIC ACTIVITY OF VARIOUS FORMS OF VITAMIN A

Vitamin A occurs principally as a mixture of various fatty acid esters in natural products, but in concentrates prepared by saponification it is present as the free vitamin A alcohol. The relative potency of these different forms of vitamin A, and of their carotenoid precursors, is important in arriving at the vitamin A requirement of various species on mixed diets.

Braude and associates (*Biochem. J.* **35,** *693 (1941)*) attempted to determine the potency of vitamin A alcohol and natural vitamin A esters. Both were purified by molecular distillation and fed at two levels to rats and swine on low vitamin rations. Beta carotene and zeaxanthin were also fed. Growth and vitamin A stores in the liver at the conclusion of the experiment were used to determine the minimum requirement.

As had been found in earlier work, zeaxanthin was inactive for both species, although a paper by Lund (*Beretn. Forsögsla., Kbh. p. 180 (1938)*) reported that this pigment prevented vitamin A deficiency in pigs. Pigs made less efficient use of beta carotene than rats and required approximately 7.7 micrograms of vitamin A or 40 micrograms of beta carotene per kilogram of body weight per day. There appeared to be no difference in the activity of free vitamin A alcohol and natural vitamin A esters. These results are in agreement with previous findings of Guilbert, Howell, and Hart (*J. Nutrition* **19,** *91 (1940)*) on the minimum requirements of vitamin A and carotene for cattle, sheep, pigs, and horses. These four species need from 5.3 to 7.1 micrograms of vitamin A or 24 to 34 micrograms of carotene per kilogram of body weight per day to satisfy minimum requirements.

By definition, 0.6 micrograms of beta carotene is 1 I.U., and recent data indicate that by rat assay vitamin A is about twice as active, that is, 1 I.U. is 0.3 micrograms of vitamin A. These figures indicate that the rat can form only 1 molecule of vitamin A from a molecule of beta carotene although the statement still commonly appears in textbooks and elsewhere that beta carotene forms 2 molecules of vitamin A in the body. On the other hand, for the species studied by Guilbert *et al.* and Braude *et al.* carotene appears approximately one fourth as active as vitamin A. If such results are expressed in I.U. it is clear that approximately twice as many units of beta carotene are required as of vitamin A. That man is similarly an inefficient converter of carotene is indicated by the results of Booher and co-workers (*J. Nutrition* **17,** *317 (1939); Ibid.* **18,** *459 (1939)*), who found that from 25 to 57 I.U. of vitamin A were required to maintain normal dark adaptation in adults, whereas from 43 to 103 I.U. of carotene were required. Translated to a weight basis these figures are 7.5 to 17 micrograms of vitamin A and 26 to 62 micrograms of carotene. These results also indicate that there may be marked differences in the ability of individuals to utilize vitamin A and carotene.

It is to be expected that figures obtained for the minimum vitamin A requirements will depend somewhat upon the delicacy of the criteria used for determining them. Using histologic methods and blood levels of vitamin A as their criteria of adequacy, Boyer and co-workers (*J. Dairy Sci.* **25,** *433*

(*1942*)) reported that 18 micrograms (60 I.U.) of vitamin A or 75 micrograms (125 I.U.) of beta carotene are required per kilogram of body weight per day by the Holstein calf. The vitamin A requirement of Guernsey calves was the same when fish oils were fed but was 125 micrograms (208 I.U.) of carotene per kilo of body weight. Such high values need to be confirmed but again emphasize the difference in efficacy of vitamin A and carotene, and point to individual variation in utilization.

Numerous authors have emphasized the poor absorption of carotene that may be obtained when various foods are fed: van Eekelen and Pannevis (*Nature* **141,** *203* (*1938*)); Eriksen and Höygaard (*Klin. Wchnschr.* **20,** *200* (*1941*)); Wald, Carroll, and Sciarra (*Science* **94,** *95* (*1941*)); Virtanen and Kreula (*Ztschr. f. physiol. Chem.* **270,** *141* (*1941*)). For example, it has been reported that as little as 1 or 2 per cent of the carotene in raw carrots may be absorbed and it is apparent that not only the source of carotene, but also the method of preparation, cooking, and fineness of division are important. Obviously any great variation in the availability of carotene in different food sources or among different individuals is important in attempts to define the daily requirement of vitamin A for average individuals.

The recommended daily allowance for vitamin A as given by the National Research Council is 5000 I.U. for an adult and it is pointed out that the requirement may be less if provided as vitamin A or greater if provided as carotene. This value represents the best compromise that we can make today, but at the same time stresses the need for more clearcut data on the factors involved in carotene utilization.

THIAMINE IN THE INFANT'S DIET

Whole raw milk contains approximately 45 micrograms of thiamine per 100 g., and pasteurized milk contains a lesser quantity, varying with the process used but often in the range of 25 to 40 micrograms. The average man, consuming the recommended one pint of milk per day, might therefore expect to obtain approximately 15 per cent or more of the daily thiamine requirement from this source. It is certain that most adult Americans do not consume as much as a pint of milk per day, but other satisfactory food sources of thiamine can be substituted. In early infancy, however, milk is the only natural source of thiamine and remains an extremely important source throughout this stage of life. It would be of value then, to have reliable information on the content and availability of thiamine in the various types of milk commonly fed to infants.

Knott (*Am. J. Pub. Health* **32,** *1013* (*1942*)) performed thiamine assays by the rat growth method on pasteurized milk, boiled (three minute) pasteurized milk, evaporated milk, and human breast milk. The average thiamine content of the boiled milk was 24 micrograms per 100 ml. in contrast to an average of 26 micrograms for unboiled pasteurized milk. Since the range for both milks was from 18 to 35 micrograms, it is apparent that the three minute boiling period causes little or no destruction of thiamine. In evaporated milk, considerable loss of thiamine occurs during the longer processing and storage period. The thiamine content of evaporated milk (held three and a half months) ranged from 13 to 27 micrograms per 100 ml. of reconstituted whole milk, with destruction of the vitamin during evaporation amounting to 23 to 35 per cent for four lots of milk tested. An even more serious loss occurred during storage, reaching 50 per cent after one year in two samples, and more than 50 per cent in only two months in another sample. The destruction upon storage is most rapid during the first few

months, and appears to be influenced by the degree and duration of heat during processing, the temperature during storage, and the hydrogen ion concentration of the milk.

The thiamine content of manually expressed breast milk of 17 women ranged from 3 to 18 micrograms per 100 ml., a figure considerably below that of cow's milk, although a certain doubt is cast on these figures by a 2 to 4 day storage period at a higher pH than occurs in pasteurized and evaporated milk. An indication was found that the diet of the mother might influence the thiamine content of the breast milk since the thiamine content of breast milk of "women successfully nursing young infants" was considerably higher than that of mothers with a "limited knowledge of fundamental principles in nutrition." These are hardly adequate criteria, however, for satisfactory evidence on this point.

In an attempt to evaluate the significance of the thiamine content of the different types of milk, Knott determined the blood cocarboxylase (thiamine diphosphate) of a few infants maintained (a) on evaporated milk formulas, (b) on manually expressed human milk, and (c) on breast feeding. The lowest values of 0.5 and 1.0 micrograms of cocarboxylase per 100 ml. of blood were obtained on infants receiving manually expressed breast milk as contrasted to blood levels of 3 to 4 micrograms in nursing infants and those given evaporated milk formulas. In order to raise this figure to 5 micrograms, which was considered to be "a normal value for health," it was necessary to add crystalline thiamine to the formula. Even this figure of 5 micrograms per 100 ml. of blood is somewhat below the average normal figure found for adults by Goodhart (*J. Biol. Chem.* **135,** *77 (1940); J. Clin. Invest.* **20,** *625 (1941)*).

No data are presented by which to judge the relative availability of the thiamine in evaporated milk and breast milk. However, the maximum intake that seemed possible on an evaporated milk formula was 190 micrograms daily, and the author's assay of breast milk indicated that "this type of milk cannot furnish 200 micrograms of thiamine daily." These figures are considerably below the 400 microgram daily intake recommended for 6 to 8 month old infants by the National Research Council. Although it is as yet more difficult to appraise the status of thiamine nutrition than of ascorbic acid, studies of the type reported may lead to fortification of milk formulas with thiamine as well as ascorbic acid. It is certainly not premature to suggest the inclusion of thiamine-rich foods in the infant's diet as early as feasible.

COLLABORATIVE STUDY OF RIBOFLAVIN ASSAY METHODS

At the 1941 meeting of the American Chemical Society, a committee, consisting of about fifty individuals representing nearly the same number of university and industrial research laboratories, was organized to study assay methods for riboflavin.

An advisory committee was first appointed which assumed responsibility for making preliminary assays of referee samples by methods employed in their respective laboratories. Each member received two samples for assay, one of which was patent flour and the other the same flour containing added riboflavin. On the basis of this preliminary work, the advisory committee recommended methods which were to be tested in a more comprehensive assay program by a larger group of collaborating laboratories. The report of the Chairman of the Advisory Committee, Dr. J. S. Andrews, gives a detailed account of the findings (*Cereal Chem.* **20,** *3 (1943)*).

Two general types of assay methods were employed in the preliminary program. These consisted of several modifications of the Snell and Strong (*Ind. Eng. Chem. (Anal.*

Ed.) **11,** *346 (1939)*) microbiologic method, using the *Lactobacillus casei* organism and modifications of the fluorometric method as described by Hodson and Norris (*J. Biol. Chem.* **131,** *621 (1939)*) and Conner and Straub (*Ind. Eng. Chem. (Anal. Ed.)* **13,** *385 (1941)*).

As a result of the preliminary work, the advisory committee recommended that the method of Snell and Strong be used by the large collaborative group, with the exception that all workers were asked to make their assays on autoclaved aqueous extracts which had been digested with takadiastase and filtered.

Fluorometric results obtained in the preliminary studies agreed well with those obtained by the microbiologic method, leading to the belief that both methods "were capable of satisfactory application to cereal products." Difficulty was experienced however in the selection of a preferred fluorometric method. Collaborators were finally asked to employ a combination of the Hodson and Norris and the Conner and Straub methods.

Collaborators were asked to study the procedure with and without permanganate treatment and all were encouraged to submit values obtained with any other fluorometric method employed in their respective laboratories. Unfortunately, the number of collaborators who completed the program was smaller than had been hoped for. Consequently, the committee states that the results are by no means final, but require further study before they can be unqualifiedly accepted.

In the collaborative studies, about 27 laboratories participated in the analysis of three referee samples. These consisted of whole wheat flour, whole wheat bread, and dried yeast. Values obtained by the fluorometric method varied ± 40 per cent from the average, and similar tendencies were exhibited by the microbiologic method. It is interesting to note, however, that averages obtained on flour, for example, showed a difference of only 0.02 micrograms per gram when all data from both methods were compared. "Other methods" used by seven collaborators gave close agreements on one sample and variable results on another sample. Yeast gave uniformly better results with both types of assay methods than did whole wheat flour or whole wheat bread. On the other hand, "other fluorometric methods" gave less uniform results with yeast than with the cereal samples. Discrepancies between laboratories are attributed to variations in technic and differences in manipulative skills.

The committee arrived at no clearcut conclusions other than to observe that both methods give equally satisfactory results with the types of cereals assayed and that no precise decision can be reached at this time regarding preferred methodology. The committee recommends that each analyst decide, from his own experience, which method is preferable.

Riboflavin assays differ from thiamine assays in that chemical and microbiologic methods for riboflavin estimation cannot be confirmed by suitably accurate animal assays. Andrews discusses in considerable detail suggestions and difficulties reported by various collaborators. Many of these suggestions will be of value to workers who are experiencing difficulty in obtaining satisfactory riboflavin values.

In summary, microbiologic methods of riboflavin assay yielded 1.15, 1.65, and 58.4 micrograms per gram for air dried samples of whole wheat flour, whole wheat bread, and yeast, respectively. Corresponding averages obtained by several fluorometric procedures were 1.11, 1.81, and 57.6 micrograms per gram. It is pointed out that incomplete removal of pigments is the chief reason for variations in fluorometric results obtained on the whole wheat bread. The committee noted somewhat greater uniformity of results

obtained by microbiologic methods, although fluorometric methods "show sufficient promise to justify equal consideration."

Collaborative studies of this type are to be encouraged, since they are most helpful in bringing advantages and disadvantages of various procedures to the attention of less experienced workers. While assay methods for riboflavin are not wholly satisfactory, collaborative work of this type should pave the way for the development of more accurate and satisfactory methods. The detailed suggestions and observations of these experienced collaborators should be studied carefully by every investigator interested in riboflavin assays.

UNUSUAL FOODS OF HIGH NUTRITIVE VALUE

In every war special attention is focused on foods. With our modern knowledge of nutrition it is fitting that emphasis should be on foods of high nutritive value. Wilder and Keys (*J. Am. Med. Assn.* **120,** *529 (1942)*) have provided a scholarly discussion of unusual foods of high nutritive value in one of the articles in the Handbook of Nutrition that has been appearing serially in the Journal of the American Medical Association. Most of us agree at once with the view of these authors that modern man might advantageously reconsider many of his food customs. In addition to the well known protective foods which deserve high rank in the diet there are some less well known foods of which greater use could be made. A number of recent reports show that considerable progress has been made in the search for additional sources of vitamin C, one of the more critical elements of diet under wartime conditions.

The vitamin C content of the diet is known to be one of the weak points in the nutritional status of the people in Great Britain, and nutritionists there have been devoting considerable study to methods of assuring an adequate intake of this important vitamin. It may come as a surprise to many persons to learn that the people in the territory of Hawaii have experienced some difficulty in securing adequate amounts of vitamin C in their foods, now that importations of citrus fruits from the American mainland no longer are obtained in normal quantity. Apparently the growing of tomatoes and other common and important sources of vitamin C cannot be practiced on the islands to an extent that would enable these foods to solve the problem. Investigators at the University of Hawaii therefore have studied the available local foods and have developed directions for the feeding of guava "juice" or fresh solo papayas to infants and small children who in the past customarily received orange juice. These native Hawaiian foods contain about 80 mg. or more of ascorbic acid in each 100 g., or about twice as much vitamin C as ordinary oranges.

In World War I it was learned that the yellow turnip or rutabaga, like a number of other root crops, is a rich source of the antiscorbutic vitamin. A juice may be prepared from the rutabaga which approximates the citrus fruit juices in vitamin C content. Much interest has been aroused recently by reports that the black currant and wild rose hips (the hip is the fruit of the rose) are excellent sources of ascorbic acid. Hunter and Tuba (*Canad. Med. Assn. J.* **48,** *30 (1943)*) have made a study in Canada of rose hips and the leaves of evergreens as sources of vitamin C. From their report it appears that interest in these sources of vitamin C first developed in Russia, where as long ago as 1936 a patent is said to have been granted for a method of preparation of vitamin C from rose hips. The amounts of vitamin C reported to occur in the fruits of Russian roses are astounding, amounting in one instance to as much as 14.6 per cent of the dry material. It is claimed that the higher

the latitude at which the roses grow the greater is the amount of vitamin C in their fruits. The same phenomenon is true in Britain, where larger amounts of vitamin C have been found in hips collected in northern England and Scotland than in those collected in the south of England and in Wales, but the amount of vitamin C is considerably less than has been reported by scientific workers in the Soviet republic. The Canadian investigators made 119 estimations on 43 lots of material and found a range of from 882 to 3676 (average 1637) mg. of vitamin C in 100 g. of raw fruit; or from 2.65 to 11.03 (average 4.91) per cent ascorbic acid, on the dry basis. The average value in samples picked on October 6, 1942, of fruits of *Rosa acicularis* was 6.28 per cent, of *R. woodsii* 4.87 per cent, and of *R. Arkansana* (the common prairie rose) 5.62 per cent, all on the dry basis.

A ripe rose hip with the stalk and flower residues removed is said to weigh about 1 g., of which two-thirds is edible fleshy material and one-third inedible seeds and accompanying tissue. It is calculated that an average rose hip contains about 10 mg. of vitamin C and that 3 of the fruits are equivalent in vitamin C content to a good orange. The flesh of rose hips has a bland taste, but the fine hairs of the seeds are unpleasant in the mouth, a fact which may explain the failure of settlers and farm women to have used such material in the making of preserves. The authors point out that a clear, pale yellow juice which contains about 0.5 per cent ascorbic acid, or 20 mg. of vitamin C to the teaspoonful, may be obtained by putting the fruits in a saucepan, covering with water, boiling for fifteen minutes, breaking the fruit to a pulp, and expressing and filtering the material through flannel. The Canadian investigators reported no appreciable loss of vitamin C by boiling for periods up to thirty minutes, and also that there is no loss after two months when the material is made in the form of preserves. The fruit may also be dried and, after removal of the seeds, powders prepared which contain 5.4 per cent ascorbic acid.

Professor E. H. Moss of the Department of Botany of the University of Alberta, where this interesting work was done, has estimated that the wild rose hip crop of Alberta is approximately half a million tons. Thus there appears to be a potential supply of about 5000 tons of ascorbic acid in this material, or enough to give 140 million people 100 mg. of ascorbic acid daily for a year.

The observations on rose hips are so impressive that they overshadow the additional observations of interest which these authors have made on the vitamin C content of still another winter crop, the leaves of common evergreens. Hunter and Tuba found from 103 to 317 mg. of ascorbic acid in each 100 g. of fresh leaves, depending on variety. Thus the vitamin C content of the leaves of evergreens is about one-tenth that of rose hips, but it is from three to five times higher than in orange juice. It is facts such as these that may lead to a practical solution of the problem of getting enough vitamin C for our own use and for the people of conquered countries during war and postwar conditions.

DIET AND HEPATIC TUMOR FORMATION

Of the many types of experimental tumors now available to investigators, those most susceptible to dietary modification appear to be the hepatic tumors due to p-dimethylaminoazobenzene (butter yellow). Rats fed certain deficient diets, such as a mixture of rice and carrots, readily develop liver tumors when the dye is added to the ration, but if a protective food is fed in addition, the effectiveness of the dye is reduced and the incidence of tumors is lowered significantly. The protective foods include liver, yeast,

milk, and mixtures of certain grains, as well as extracts and concentrates prepared from these materials. Kensler, Sugiura, Young, Halter, and Rhoads (*Science* **93,** *308* (*1941*)) demonstrated that the effect of these cruder substances could be duplicated with a mixture of casein and riboflavin, although either alone failed to reduce the incidence of tumors.

Essentially similar results were obtained by Miller, Miner, Rusch, and Baumann (*Cancer Research* **1,** *699* (*1941*)) who employed semisynthetic diets. Tumors were produced most readily when the level of casein was 10 or 12 per cent, and when the water soluble vitamins were supplied as a rice-bran concentrate high in all the B-vitamins except riboflavin. A survey of 34 diets indicated that the protective combinations were invariably high in protein and in the B-vitamins including riboflavin.

A number of other facts seem to be in harmony with these dietary experiments. For one thing, cancer of the liver in man is much more frequent in the Orient than in Europe and America, and the Oriental diet tends to be low both in protein and in certain of the B-vitamins. Furthermore the Oriental diet is high in rice, and the experimental diets employed most successfully for the production of liver tumors in rats likewise contained rice or rice extract, although rice is not indispensable for tumor formation.

Kensler and co-workers have observed that the ingestion of dimethylaminoazobenzene results in an increased excretion of riboflavin in the urine and a decreased amount of the vitamin in the tissues. Since riboflavin is an essential component of several enzyme systems, one effect of the dye might therefore be to reduce the concentration of the vitamin to such a low level that its enzymatic potency no longer suffices for the maintenance of normal tissue. An enzymatic effect is further suggested by Kensler, Dexter, and Rhoads (*Cancer Research* **2,** *1* (*1942*)) and Kensler, Young, and Rhoads (*J. Biol. Chem.* **143,** *465* (*1942*)) who observed that certain cleavage products of the carcinogenic azo dyes inhibit yeast enzyme systems which require thiamine pyrophosphate and the nicotinamide coenzymes for their activity. A direct demonstration of an effect on the riboflavin enzymes themselves, however, has not as yet been made.

While these experiments are important, both in themselves and in the researches they are provoking, it would be premature to ascribe a general anticarcinogenic significance to the combination of casein and riboflavin. The effects to date have been observed only in hepatic tumors due to the azo dyes, and then mainly on crude diets in which protein and riboflavin happen to be limiting factors. It is entirely possible that limiting amounts of other nutrients might act in a similar way.

THE FARMER'S WARTIME FEEDING PROBLEM

Almost insurmountable handicaps face the American farmer in his efforts to meet the 1943 food production goal, according to Hunter (*J. Am. Vet. Med. Assn.* **102,** *217* (*1943*)). The 1943 production goal for meat is 16 per cent higher than in 1942. The milk production goal for 1943 calls for but 2 billion pounds increase over 1942 production, probably in recognition of the potential labor shortage on dairy farms. The poultry raisers are asked to increase production of chickens by 28 per cent, turkeys by 15 per cent, and eggs by 8 per cent. Not until these rather harmless appearing percentages are translated into millions and billions of pounds of food is it possible to appreciate the problem that confronts the American farmer.

The production of farm animals on such a gigantic scale calls for great quantities of

additional feeds. As a result, the country is faced with a serious feed shortage. Hunter points out that there is little likelihood of a carbohydrate shortage, owing to ample supplies of cereal grains. However, efficient production of hogs cannot be obtained on corn alone, since this cereal must be supplemented with protein of good quality and with vitamins and minerals. He points out that 12 bushels of corn are required to produce 100 pounds of pork. Six bushels of corn properly supplemented by 40 to 50 pounds of a good protein concentrate will do the same job. Molasses, formerly used as a source of energy and to improve palatability, is restricted by government order because of the need for molasses in the industrial alcohol program.

Animal feeds are now less rich in fats because fats are being removed more carefully to furnish fats for war purposes. Nevertheless, this is thought not to be a matter of great nutritional importance. The only mineral ingredient of livestock feeds that will be lacking is bone meal. It is estimated that the 1943 supply of this important ingredient will be short by about 170,000 tons.

A vitamin shortage is unlikely, in the opinion of the reviewer, although alfalfa leaf meal production will be about 98,000 tons short of the nation's requirements. Owing to such sources of vitamin D as irradiated yeast and activated 7-dehydrocholesterol, the shortage of fish liver oils will not be seriously felt. Fermentation residues promise to make up in part for the shortage of such riboflavin carriers as dried liver and milk by-products. However, it must be borne in mind that the latter feed ingredients may also carry other necessary members of the vitamin B-complex that are not present in fermentation residues (many students of the broad problem of animal feeding believe that there will be a moderate over-all deficiency of riboflavin, niacin, and vitamin A supplies).

All experts in domestic animal nutrition are agreed that the most serious problem confronting the livestock feeder is the shortage of protein concentrates. Without adequate supplies of protein of high biologic value, it is impossible to obtain optimal production of meat, milk, and eggs. Hunter states that the Feed Industry Planning Committee estimates that the 1943 shortage of high protein concentrates will be in excess of 1,810,000 tons. The estimated shortages of protein concentrates for 1943 (in tons) are recorded as follows: meats and tankage, 263,000; fish meal, 270,000; soybean oil meal, 676,000; cottonseed meal, 75,000; linseed meal, 269,000; dried milk, 112,000; gluten, 145,000.

Soybean production was doubled in 1942. However, the existing soybean processing plants were unable to handle the increased crop. As a result, the amount of soybean oil meal made available for livestock feeding was not increased proportionately. On account of the high oil content, it is impossible to feed unprocessed soybeans successfully. However, soybean oil meal is an excellent source of the essential amino acids and can be used successfully as a substitute for meat scraps, tankage, fish meal, and milk, providing the ration is properly supplemented with minerals and vitamins.

Hunter concludes that the serious livestock feeding situation can be relieved by (1) receiving government permission to increase processing capacity, particularly for soybean oil meal and dehydrated alfalfa; (2) by relaxing restrictions on importation of animal proteins; (3) by reducing protein in livestock feeds to the lowest efficient levels; (4) by feeding high protein feeds to livestock with highest feed requirements and, possibly, by finishing off meat producing animals on cereal grains, without added protein concentrates; (5) by disposing of nonproducing animals (for meat) to save feed; and (6) by conserving all home grown feed and by preventing waste.

It is thus evident, even to those unfamiliar with agricultural problems, that the Ameri-

can farmer is faced with a serious situation. He is being asked to raise more crops and to breed and feed more livestock, with less experienced help and with inadequate supplies of farm machinery, fertilizers, and livestock feeds of high nutritive value.

GROWTH OF CHILDREN

In a discussion of the biologic significance of the vitamins, Professor C. A. Elvehjem of the University of Wisconsin has pointed out (*Chapter I, A Symposium, The Biological Action of the Vitamins, University of Chicago Press, Chicago (1942)*) that investigators in nutrition a few years ago were accustomed to spend a great deal of time plotting the growth curves of experimental animals. The nature of nutrition work in the laboratory has changed somewhat but the fact remains that the growth of young animals is extremely dependent on the quality and quantity of the food supply. On a restricted diet the changes in body weight afford a delicate index, more delicate than those who have not had experience with the methods can appreciate, of the adequacy of the diet. Some of the vitamins are less directly involved in growth, namely vitamins E and K and perhaps choline. But even with these factors it is possible to demonstrate a retardation of growth when any one vitamin is eliminated from the diet of a suitable experimental animal for a sufficient length of time. Good nutrition of experimental animals results in good growth and, in adult animals, in maintenance of normal body weight.

The application of ideas regarding the nature of growth to human beings has not been thoroughly explored for reasons that are all too apparent to the investigator in human nutrition. For one thing there is the long period of human immaturity, which is greater in proportion to total life span than that of any other animal. Another complicating factor is the influence of heredity and racial characteristics, for man is not of homogeneous stock like a colony of white rats. Yet in every large metropolitan school, and in many smaller ones, measures of height and weight of pupils are made routinely, and probably just as routinely discarded because their interpretation is so difficult. Knowing the age, sex, height, and weight of a child, we are still far from knowing whether the child has reached its normal attainment or not. Sometimes such studies, however, produce results of interest. Recently there has been published a height and weight survey of elementary schoolchildren in Toronto which was completed during the year 1939 (*Department of Trade and Commerce, Dominion Bureau of Statistics, Social Analysis Branch, A Height and Weight Survey of Toronto Elementary School Children, Ottawa, Canada 1939 (1942)*). Approximately 78,000 boys and girls were examined and the results have been compared with a similar survey, made in 1923, of about 59,000 children. As has been found in other similar comparative studies, there has been an increase in both height and weight of the schoolchildren. An interesting high light of the Toronto study is the difference in stature of the children depending on the occupation of the father. The children of professional workers were tallest, while those of unskilled laborers, unemployed, pensioned, and retired classes were the shortest. No doubt economic factors are involved, but it would seem that knowledge of nutrition and sanitation also are important. Evidence was also obtained which indicates that the heavier and taller children were brighter or more intelligent, as measured by their grade in school, than their fellows.

While such observations as have been reported from Toronto and other localities provide an interesting picture of population

groups as a whole—better nutrition is no doubt one of the most important factors concerned with the improvement—these studies do not answer the question of the status of the individual child. It is possible that the application of the "Grid method" of Wetzel (*J. Am. Med. Assn.* **116,** *1187 (1941)*) will afford a better rating of physical status of the individual child. Wetzel claims that in addition to data on the weight, height, age, and sex of the child, one can obtain objective ratings on physique, development, nutritional grade, physical status, and other matters of importance, such as relative age advancement or retardation, maturation, basic heat production, and daily caloric requirement. The chart or "Grid," as Wetzel calls it, is the result of his theoretical and practical studies of the phenomena of growth for more than twenty years, and it would seem to be worthy of careful consideration by all persons interested in health and development of human beings between the ages of 2 and 20 years. Each individual has a growth pattern of his own, but in general it is possible to classify the growth of children in several principal channels of physique, namely the obese, the stocky, good, fair, borderline, and poor. A single examination reveals but little, but repeated examinations show definitely whether a child is developing along his own channel of growth or has deviated from it.

A revealing case demonstration of the application of the Grid method has been provided recently (*J. Pediatrics* **22,** *82 (1943)*). Wetzel presents the record of weight and height of a boy as taken at intervals from 7 years to 12½ years of age. The most that could be concluded from an inspection of the data would be that this boy is growing regularly both in height and weight, and is of average attainment. When the data are plotted on the Grid it is shown clearly that between the ages of 9.5 and 12.5 years this boy had not been developing properly. Physical examination revealed little of moment, but the history showed that the boy, his mother, and three other children were obliged to go on relief when he was 9 years old. Evidently the decreased economic circumstances affected development, but the diagnosis of nutritive failure would not have been possible until the condition had progressed further than it had, possibly to such an extent that complete recovery might have been difficult. A complete history of this case is provided in the present report and in a later publication (*J. Pediatrics* **22,** *208 (1943)*). Wetzel claims only that the Grid method enables the examiner to screen out the underdeveloped child from the normal. It has been found that about 30 per cent of all children examined show a developmental lag and it is in this group that more thorough study can be made by the examining physician who is thus saved the necessity of perfunctorily going over 70 per cent of the children whose development is normal.

Of course there are many diseases and conditions which might be present in children and which would be missed if consideration is given only to determinations of height and weight. Abnormal tonsils, defective breathing, and dental, postural, and eye defects may not show up, but as Wetzel has pointed out, many routine medical histories reveal little more than that the child is living. If it is known that a child is not developing as he should, then there is point to making a more thorough physical examination in which some findings that might otherwise be regarded as insignificant now assume a greater importance. The Grid method, as Wetzel visualizes its application, offers an opportunity for making a systematic program of investigation of physical development. Growth depends on many things, including the calories, protein, minerals, and vitamins in the diet. With so much current emphasis on the vitamins it is important to give special attention to methods of nutritional appraisal that take into consideration some of the other factors that contribute to the development of sound bodies in children.

POLYNEURITIS CAUSED BY THIAMINE DEFICIENCY

During the past few years many clinicians and investigators have begun to wonder if the polyneuritis of beriberi were not really caused by deficiency of one of the B-vitamins other than thiamine. They have been puzzled by the fact that polyneuritis has not developed in human subjects with induced thiamine deficiency (Williams, Mason, Smith, and Wilder, *Arch. Int. Med.* **69,** *721 (1942)*) and impressed because deficiencies of riboflavin, pyridoxine, or pantothenic acid produce neurologic manifestations in many experimental animals (*Nutrition Reviews* **1,** *137 (1943)*). Great interest, therefore, is attached to the recent report by Williams, Mason, Power, and Wilder (*Arch. Int. Med.* **71,** *38 (1943)*) that peripheral neuritis had developed in two of their subjects with induced thiamine deficiency.

In the earlier work of Williams and associates, volunteer human subjects had been given either 0.075 or 0.22 mg. of thiamine per thousand calories per day. The former allowance provided so severe a restriction of the vitamin that the deficient diet had to be discontinued because of prostration and inanition just when neuropathy seemed certain of development. On the other hand, the latter more moderate and prolonged restriction caused general impairment of mental and physical health with no detectable involvement of peripheral nerves. Therefore, it seemed desirable to find out whether a restriction intermediate between the above two allowances might, within a reasonable period, induce the syndrome of beriberi. That this plan might be successful was suggested by the experiments of Swank and Bessey (*J. Nutrition* **22,** *77 (1941)*) in which less severe restriction of thiamine or periodic administration of small doses of the vitamin permitted pigeons to live long enough to develop polyneuropathy. Accordingly, two carefully selected female volunteers were fed a diet so constructed that it provided 0.1 mg. of thiamine per thousand calories. Small doses of thiamine hydrochloride administered periodically increased the allowance 75 per cent. Supplemental amounts of vitamins A and D, ascorbic acid, choline chloride, riboflavin, pyridoxine, calcium pantothenate, niacin amide, inositol, ferrous sulfate, and tricalcium phosphate were given daily. The period of restriction lasted one hundred twenty days. The subjects experienced weakness and anorexia after about thirty days. Twenty days later, there was nausea, epigastric distress, and vomiting. At seventy days, nausea and weakness were more troublesome. One of the women complained of giddiness, the other was apathetic, confused, and noted numbness and tingling of the medial surfaces of the legs from the knees to the ankles. At ninety days, confusion and inactivity had become more conspicuous. There was tenderness of the muscles of the calves of the legs and one subject was inaccurate in her response to light touch and pin prick on the medial surfaces of her legs. After one hundred ten days the cardiac rate was slow at rest but abnormally rapid after slight exertion. The second subject complained of paresthesias and both were now unable to rise from a squatting position without assistance. During the next ten days each woman lost 2.7 kg. of weight, the first weight loss to occur during the whole period. One subject could then neither stand nor walk without support; movements of the thighs were weak and extension of the legs was barely perceptible. The second patient could walk with flexion of her knees. Vibration sense of the ankles was either impaired or absent. The achilles tendon reflex was absent in both, while the patellar reflex was absent in one subject, hypoactive in the other.

Of particular interest to physicians is the fact that the patellar reflexes became hyperactive before they became diminished or

absent. In one woman, the achilles tendon reflex was also hyperactive for a short period. This observation is important because the possibility that deep reflexes may become hyperactive in mild or subcritical polyneuritis has been debated.

Biochemical evidences of thiamine deficiency were also observed in these patients. Urinary excretion of thiamine fell to low levels a few days after the restricted diet was begun and urinary excretion of a 1 mg. test dose of thiamine was abnormally low at the end of sixty days. The heights to which plasma pyruvic acid rose after the intravenous injection of glucose increased progressively throughout the period.

After one hundred twenty days of restriction, therapeutic doses of thiamine were given while the patients remained on the same diet. Appetite, strength, and "feeling tone" had improved greatly in seven days and returned to normal within thirty days. The less advanced neurologic defects of one case were corrected by 15 mg. of thiamine daily for fifty days. In the other subject, movements of the thighs and legs returned slowly to normal but the achilles and patellar reflexes were still absent after four months.

Certainly these two subjects developed peripheral neuritis (tenderness of calf muscles, depression or disappearance of the tendon reflexes, and paralysis of the muscles of the thighs and legs) while they were being fed a diet deficient in thiamine but adequate in the other known members of the B-complex. There were no evidences of infection which might make one doubt that the neuropathology had been induced by thiamine deprivation, and the spinal fluid was shown to be essentially normal. Furthermore, the neurologic changes were reversed when the regimen was altered only by thiamine administration.

The conclusion of Williams and associates that polyneuropathy is a manifestation of late rather than early, and severe rather than mild thiamine deficiency receives support from the studies of Leblond and Chaulin-Servinière (*Am. J. Med. Sci.* **203,** *100 (1942)*). These authors produced beriberi in monkeys with a diet which provided about one-half the minimal requirement of thiamine. The animals developed signs of polyneuritis and cardiac failure. Autopsy examination demonstrated peripheral nerve degeneration. However, if monkeys were given a diet with more severe thiamine restriction, they died before any outstanding clinical symptoms or marked histologic degeneration occurred.

Therefore, the time-honored belief that polyneuritis is a manifestation of thiamine depletion has received rather convincing experimental support. The fact that certain animals do not develop polyneuropathy when thiamine deficiency is induced, but show these lesions when other components of the B-complex are withheld, only serves to emphasize the variations in host response known to occur with avitaminosis.

ASCORBIC ACID IN MILK

In these days of national conservation of essential food supplies it is extremely important that common carriers of protective food essentials be critically examined. The commercial supplies of synthetic vitamins are rightly on call for the armed forces, for medical treatment and for enrichment of standard commodities. Certain of the protective foods which have in the past been easily transported cannot be obtained as readily during the war. Citrus fruits, for example, have been shipped in abundance from the southernmost states in past years, and our people have come to rely upon oranges, lemons, and grapefruit as principal sources of ascorbic acid. Within recent years

tomatoes, which are indigenous to the entire country, have been emphasized as a source of vitamin A and ascorbic acid. Some of the other common staple foodstuffs should not be overlooked as excellent sources of vitamin C.

Milk has been much emphasized as a protective food. It has been little emphasized as an important source of ascorbic acid, yet a quart of fresh (unpasteurized) milk contains a third of the daily requirement of ascorbic acid for the adult.

Ascorbic acid occurs in two forms in milk, reduced ascorbic acid and oxidized ascorbic acid, or dehydroascorbic acid. In the presence of oxygen the reduced ascorbic acid of milk (vitamin C) is slowly oxidized to dehydroascorbic acid. Although the latter is antiscorbutic, it is unstable and upon further change loses its character as a vitamin. The relative amounts of these two forms of ascorbic acid depend upon the age of the milk, exposure to light, temperature of storage, and contact with copper. Light and traces of copper both accentuate the loss of ascorbic acid from milk, and this loss is increased with rise of temperature.

Hand (*J. Dairy Sci.* **26,** 7 (*1943*)) defined the conditions under which the determination of ascorbic acid in milk is accurate and determined the range of concentrations of dehydroascorbic acid normally found in milk. It was found that milk drawn into brown bottles and titrated immediately contained, on the average, 23.4 mg. of reduced ascorbic acid per liter. If the total ascorbic acid was determined by means of treatment with *Bacterium coli* to reduce the dehydroascorbic acid to ascorbic acid, the same amount was found. During storage, the dehydroascorbic acid content was found to increase 3 to 6 mg. per liter in twenty-four hours, and was relatively constant for six days. The reduced ascorbic acid, however, steadily declined to 19.0, 15.6, 10.9, 7.1 mg. per liter on the first, second, fourth, and sixth day, respectively.

Copper promotes the accumulation of dehydroascorbic acid in milk with a concomitant decrease in the reduced ascorbic acid. The presence of 0.1 mg. of copper per liter of milk caused a conversion of 71 per cent of the ascorbic acid to the dehydroascorbic acid form, which was three times the normal rate of conversion in the absence of copper contamination.

Pasteurization of milk destroys the dehydroascorbic acid present in the milk at time of heating. Simultaneously a slight loss of reduced ascorbic acid occurs. Commercial pasteurization has two incidental effects that may influence the relative amounts of ascorbic and dehydroascorbic acids in milk. These are the introduction of copper and exposure to light. Both hasten the loss of reduced ascorbic acid and the temporary accumulation of dehydroascorbic acid.

The titration of reduced ascorbic acid in milk was found to be an accurate measure of the ascorbic acid present only directly after milking or directly after pasteurizing. Commercial pasteurized milk contained from 1 to 6 mg. of dehydroascorbic acid provided it was not unduly exposed to light or copper contamination. In pasteurized, deaerated milk the ascorbic acid is present in the reduced form and it is stable.

These data show that commercial raw milks may contain 21 to 23 mg. of ascorbic acid per liter and pasteurized milk about 16 mg. per liter. The latter would vary over an extremely wide range, depending upon the condition of processing, as has been shown in many earlier publications.

A quart of milk, therefore, may supply a substantial part of the minimum daily requirement (35 mg.) of ascorbic acid and not a negligible portion of the 75 mg. recommended daily allowance.

NOTES

Meals in Hawaii

Many authoritative and interesting pamphlets on the nutritional aspects of foods have been prepared by the Bureau of Home Economics, the various agricultural experiment stations, and by other groups, but there is special interest in a recent bulletin by Carey D. Miller and Helen Yonge Lind entitled "Food for Health in Hawaii," published by the Hawaii Agricultural Experiment Station. The presence of many racial groups in the islands, each with its own food habits, has presented a special problem in teaching the principles of adequate nutrition. The dependence of Hawaii on the United States for many staple foods complicates the problem further. The bulletin contains some treatments of nutritional information which are likely to be peculiarly effective for teaching purposes. For example, the authors present a discussion of the nature of an adequate diet by providing a list of foods in a typical diet for sedentary adults of the Haole population. This diet, which is called nutritionally inadequate contains, for breakfast: figs and cream, toast (white bread), butter, bacon, eggs, coffee with cream; for lunch: ham sandwiches (white bread, butter, ham, mustard, dill pickle), apple pie alamode, tea; for dinner: clear soup, shoulder lamp chop, peeled boiled potato, white rolls, Harvard beets, bleached head lettuce salad, French dressing, jelly roll, coffee. This menu is deficient according to the standards of the National Research Council in calcium, vitamin A, thiamine, and ascorbic acid. The inadequacy results because of too little milk, cereals that are highly refined, and too few of the kinds of vegetables and fruits that are good sources of vitamins A and C.

In contrast, the reader is informed, a good diet might be obtained from the following meals: for breakfast: papaya with lemon, toast (whole wheat bread), butter, guava jam, scrambled egg, coffee with cream; for lunch: ham sandwiches (rye bread, butter, ham, mustard, dill pickle), avocado and pineapple salad, milk, gingerbread; for dinner: tomato juice, shoulder lamb chop, potatoes boiled in their skins, buttered string beans, wilted green lettuce with chives, lemon milk sherbet, oatmeal cookies. The recommended daily allowances are met and, in the case of vitamin C, the amount obtained is approximately three times the recommended daily allowance. Other interesting features of the bulletin are twelve practical suggestions for obtaining, retaining, and preserving the vitamins of foods, answers to twenty-eight questions about foods, fourteen rules for preserving the nutritive value of vegetables, and twelve aids to planning meals. Especially interesting is a selection showing a poor choice and a wise choice of foods purchased for a family of 4 persons for a week. (Copies of this Bulletin No. 88 may be obtained (50¢ each) from the University of Hawaii Bookstore, Honolulu.)

Child Nutrition

"The Road to Good Nutrition" written by Dr. Lydia Roberts for the Children's Bureau of the United States Department of Labor (*Bureau Publ. no. 270, Superintendent of Documents, Washington*) has a wealth of material. Much of it is taken from Dr. Robert's book "Nutrition Work With Children" and is designed to "help parents, teachers, and others in the important task of keeping children on the road to good nutrition."

Protective Foods, 1919

"Milk and the leafy vegetables are to be regarded as *protective foods*. In some degree eggs are to be considered in the same class. Milk and the leafy vegetables should be

taken in liberal amounts. The leaves should not be regarded as foods of low value because their content of protein, fat and carbohydrate is low, and the content of water high. When compared on the basis of chemical composition they appear inferior to seeds, but they have a peculiar value in their high content of fat-soluble A and of mineral elements, which makes them stand in a class by themselves among the vegetable foodstuffs." [McCollum, E. V.: *The Newer Knowledge of Nutrition, the use of foods for the preservation of vitality and health.* New York, Macmillan Co., 1919.]

Psychodietetics

The mental state as a contributory factor in the development of physical ailments and its effect upon normal utilization of food is a subject of current interest. A physical upset may be precipitated by an emotional crisis, recovery may be retarded by mental unrest, or a gastrointestinal flare may result from psychic disturbance. When eating habits need adjustment in a person whose emotions have resulted in a physical upset, or when normal reasoning power is either temporarily or permanently lost, the usual practice of dietetics is insufficient. An understanding of the mental conflict is necessary and cooperation between the psychiatrist and dietitian most desirable. Such a cooperative treatment has been termed psychodietetics by Selling (*J. Am. Dietet. Assn.* **18,** *741 (1942)*).

This subject logically embraces the use of proper food for mentally upset patients, and also a study of proper food to maintain the best mental efficiency of normal individuals. Food habits, economic or racial status, environmental factors involved in obtaining and preparing food, enjoyment during its consumption, individual reaction to the food as indicated in personal likes and dislikes, temporary mental or physical state, possible allergy or physical disability requiring modification of diet—all are intangible factors working together and resulting in individualism. Appreciation of this individualism and an understanding of psychology may make the difference between success and failure of a dietetic program.

Food for Health

A Traveling Exhibit "Food for Health" has been designed and constructed by the Cleveland Health Museum, and has been available for display since last fall. The exhibits are based on the recommendations of the National Nutrition Conference. Most of the exhibits are designed from the lay person's viewpoint of selecting and preparing foods to secure health and efficiency. The key to the units of the Traveling Exhibit is shown in the Exhibit "The Normal Diet Must Stand 4 Square" identifying vitamins, proteins, minerals, and calories by the colors used throughout the series, to represent these food constituents. What nutritious foods do for the body is found by pressing a button which illuminates a series of transparent men demonstrating "Why We Eat." The composition of foods is shown in an exhibit suitable for teaching purposes, where colored "Food Building Blocks" represent vitamins, minerals, proteins, and water. The exhibits have been used in thirty different places in eight states. They have been shown to many types of audiences, to war workers, in cafeterias of industrial plants, at county and state fairs, and in many social and educational agencies.

Recent Nutrition Books

Elements of Food Biochemistry. W. H. Peterson, J. T. Skinner, and F. M. Strong. Prentice-Hall, Inc., New York, N. Y.

Medical Clinics of North America. Symposium on Nutrition. W. B. Saunders Co., Philadelphia. March 1943. pp. 592.

Food Poisoning. G. M. Dack. The University of Chicago Press, Chicago. 1943. pp. 132.

Nutrition and Diet in Health and Disease. James S. McLester. W. B. Saunders Co., Philadelphia. 1943. 4th ed. pp. 849.